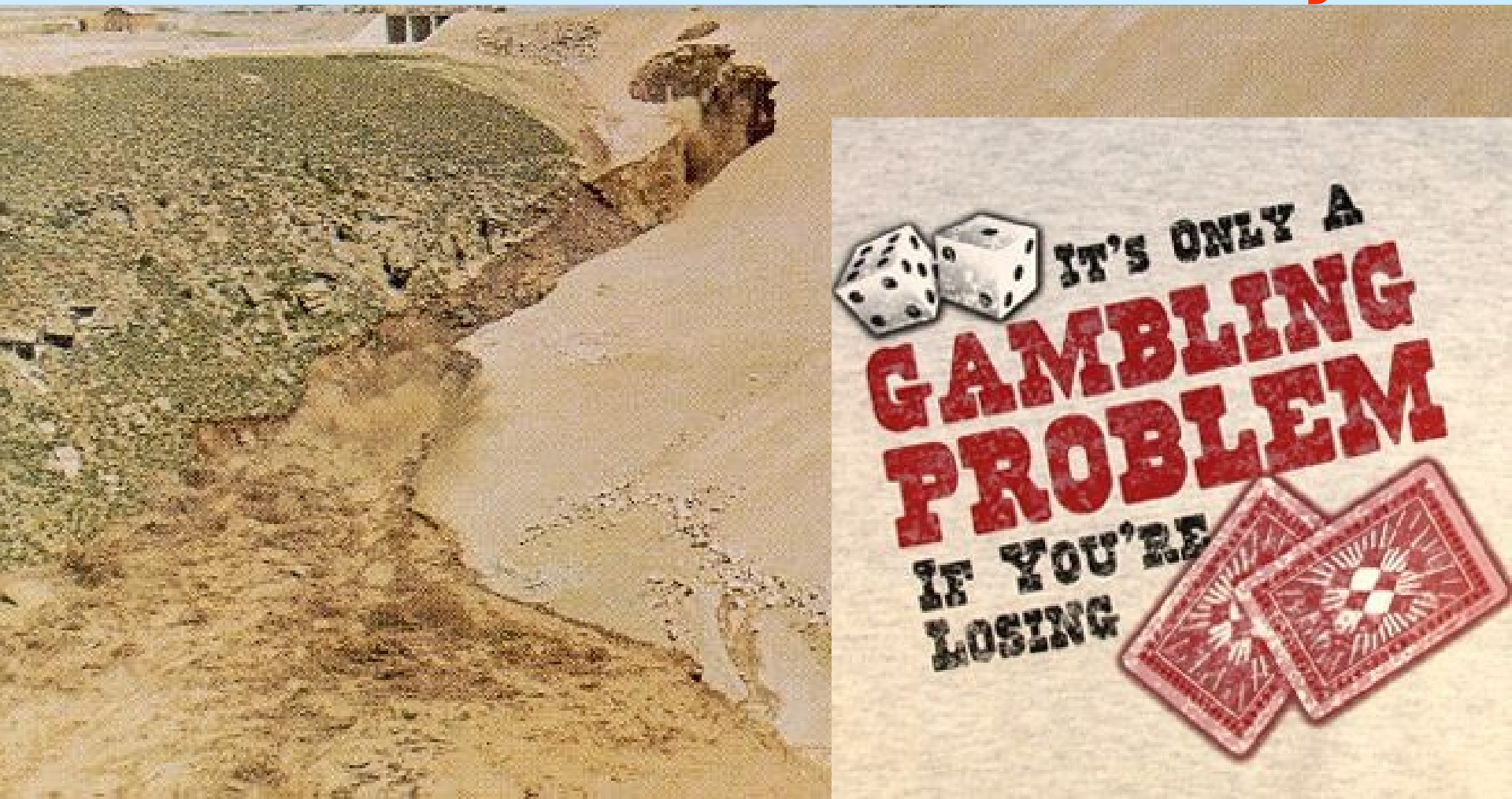
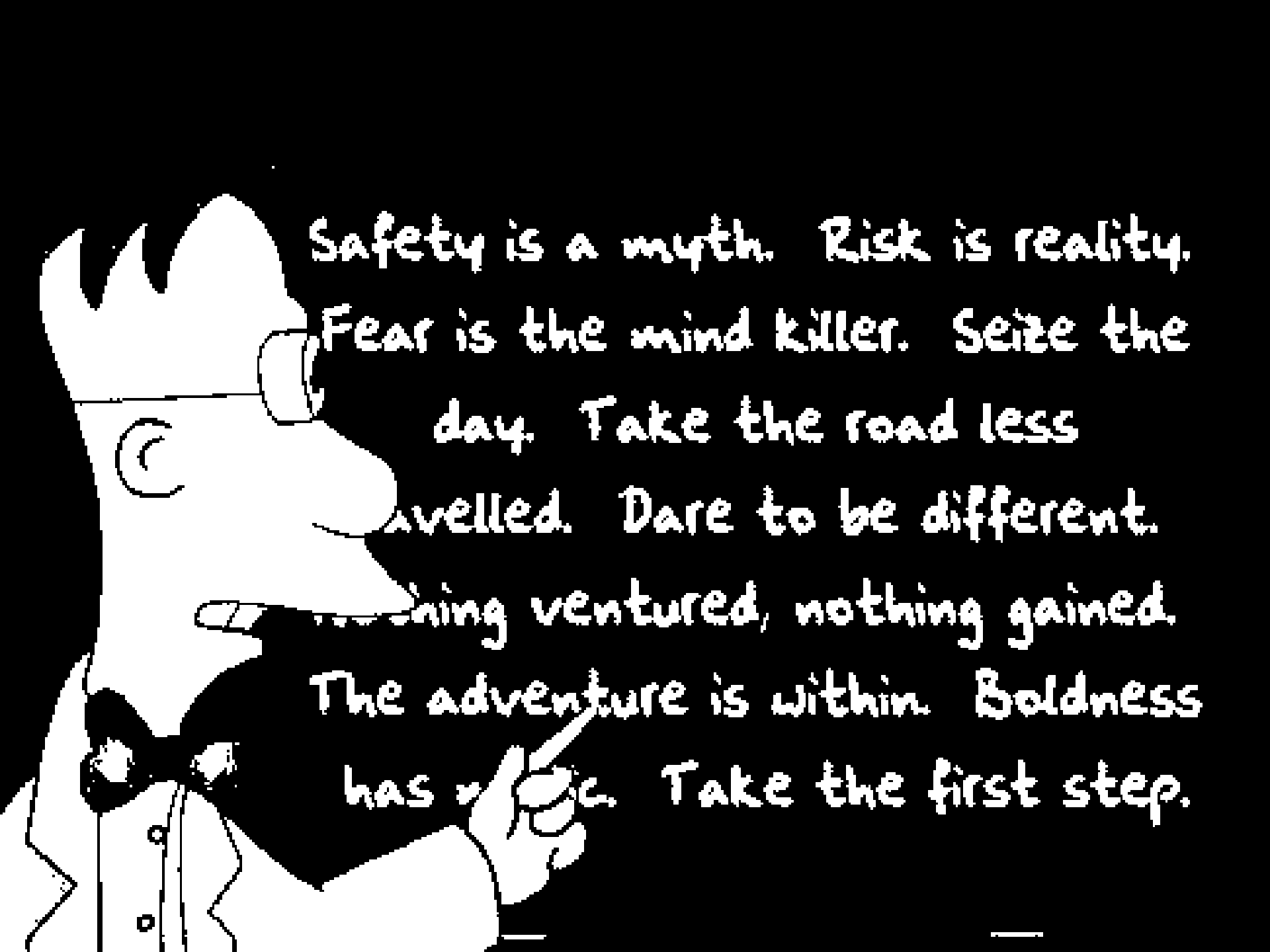
Risk and Uncertainty




Safety is a myth. Risk is reality.
Fear is the mind killer. Seize the
day. Take the road less
avelled. Dare to be different.
ning ventured, nothing gained.
The adventure is within. Boldness
has
c. Take the first step.

Continuum of Knowledge

Uncertainty

- Qualatative
- Unknown or Unknowable
- PFMA

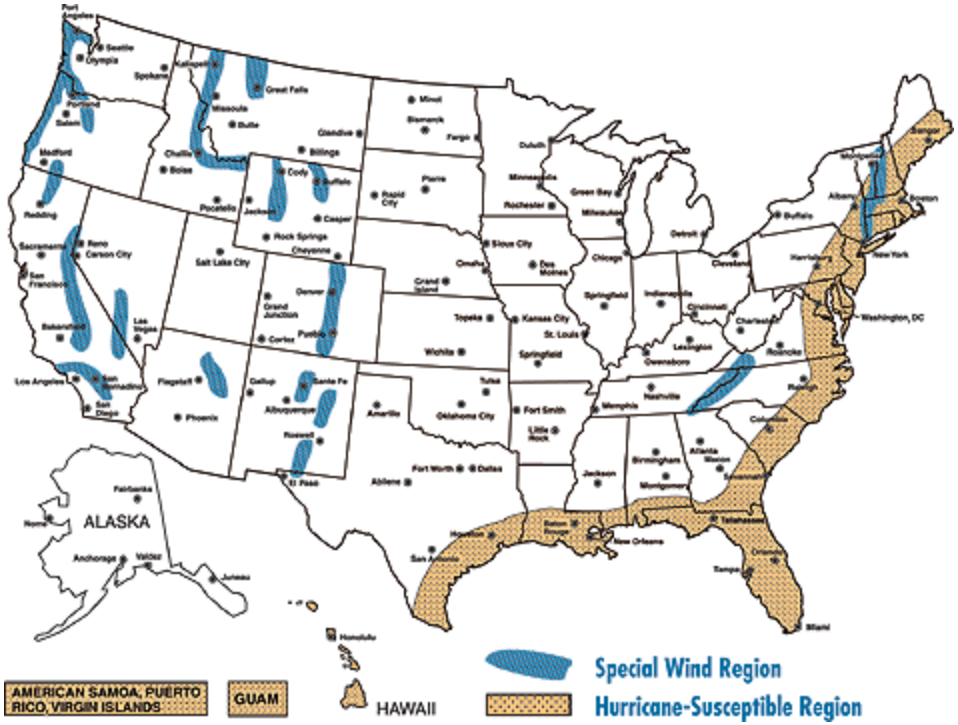
Risk

- Quantitative
- Can be estimated statistica
- 100 yr Stage

Source: IWR92rl Vol 1Guidelines for Risk and Uncertainty

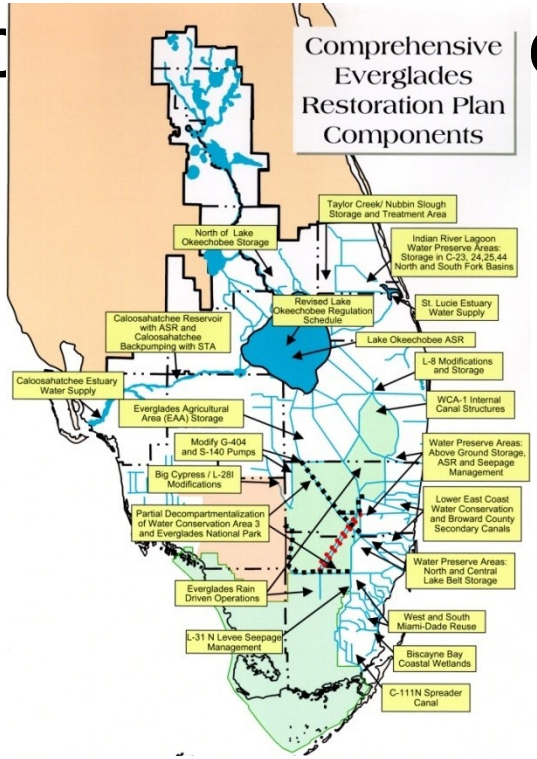
Uncertainty - Hazards

- There is uncertainty associated with hazards that include natural disasters, like the wind and hurricane susceptible regions shown below.



Uncertainty - Opportunities

- Our opportunities for gain, e.g., restored ecosystem function, improved water quality and reduced transportation costs, can also be subject to sub ertainty.


Comprehensive Everglades Restoration Plan Components
Taylor Creek/ Nubbin Slough Storage and Treatment Area
North of Lake Okeechobee Storage
Indian River Lagoon Water Preserve Areas: Storage in C-23, 24,25,44 North and South Fork Basins
Revised Lake Okeechobee Regulation Schedule
St. Lucie Estuary Water Supply
Caloosahatchee Reservoir with ASR and Caloosahatchee Backpumping with STA
Lake Okeechobee ASR
L-8 Modifications and Storage
Caloosahatchee Estuary Water Supply
Everglades Agricultural Area (EAA) Storage
WCA-1 Internal Canal Structures
Modify G-404 and S-140 Pumps
Water Preserve Areas: Above Ground Storage, ASR and Seepage Management
Big Cypress / L-28I Modifications
Lower East Coast Water Conservation and Broward County Secondary Canals
Partial Decompartmentalization of Water Conservation Area 3 and Everglades National Park
Water Preserve Areas: North and Central Lake Belt Storage
Everglades Rain Driven Operations
West and South Miami-Dade Reuse
L-31 N Levee Seepage Management
Biscayne Bay Coastal Wetlands
C-111N Spreader Canal

Uncertainty in a Project's Life Cycle

- **Planning.** Will this plan solve the problems and realize the opportunities? How much do we over- or under-estimate costs? Will project benefits be realized?
- **Design.** Are there issues with the site? Will the funds be available when needed?
- **Construction.** Will weather or labor unrest affect the work? What is the risk of injury during construction?
- **Operations.** How long will components last before failure? Will the project be maintained properly?

Risk is a Factor in all of our Jobs

Will the restoration benefits be realized?

Will transportation cost savings be realized?

How many work-related injuries can we expect

When and where will the next major flood occur?

What communities will be affected?

Will the levees be overtopped?

Will new channels lead to greater commerce?

When will the channel need to be dredged again?

How long will that lock chamber pump operate?

How many people will be exposed to flooding?

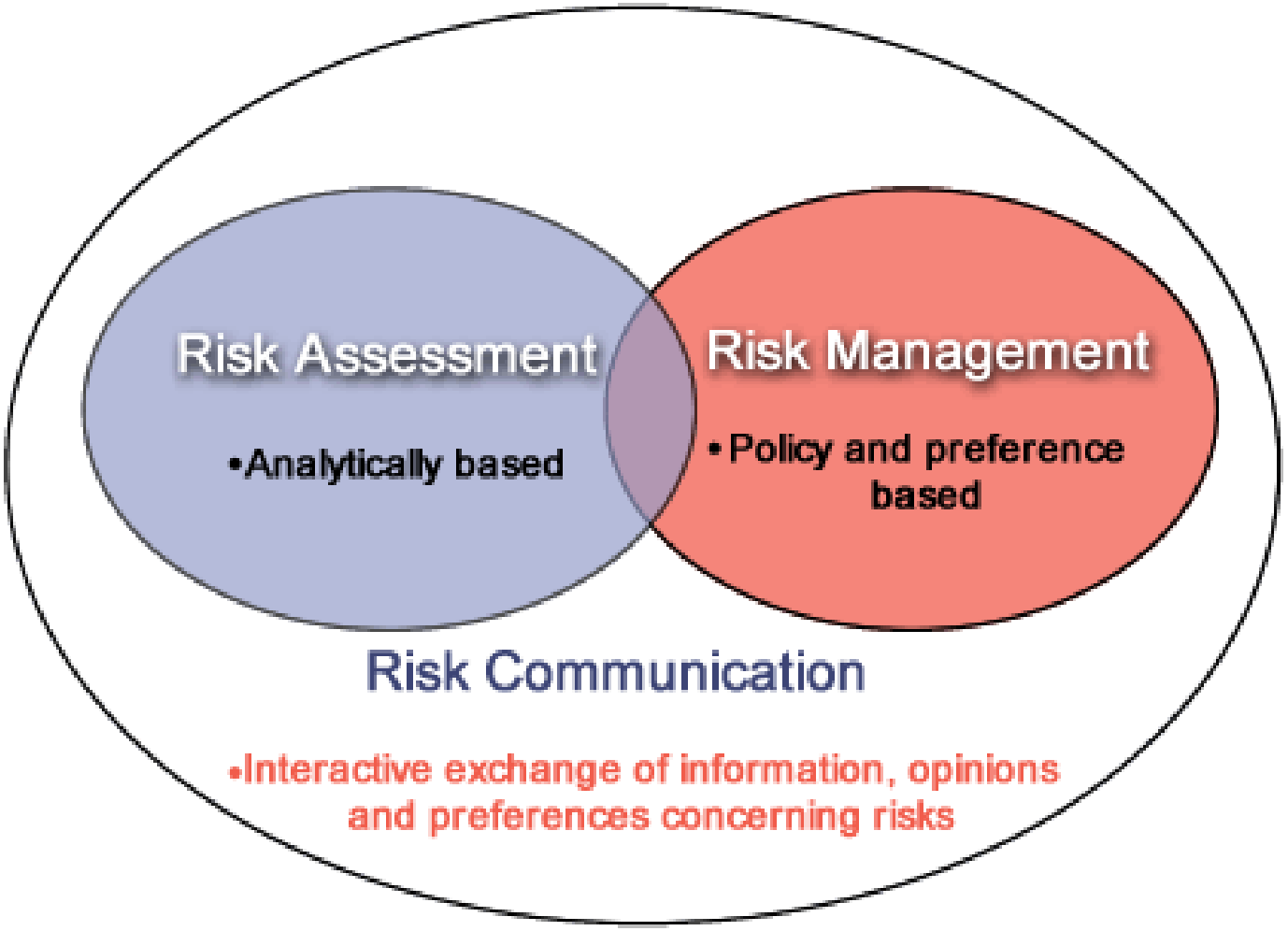
How many could die?

Why should we do ***Risk Analysis***?

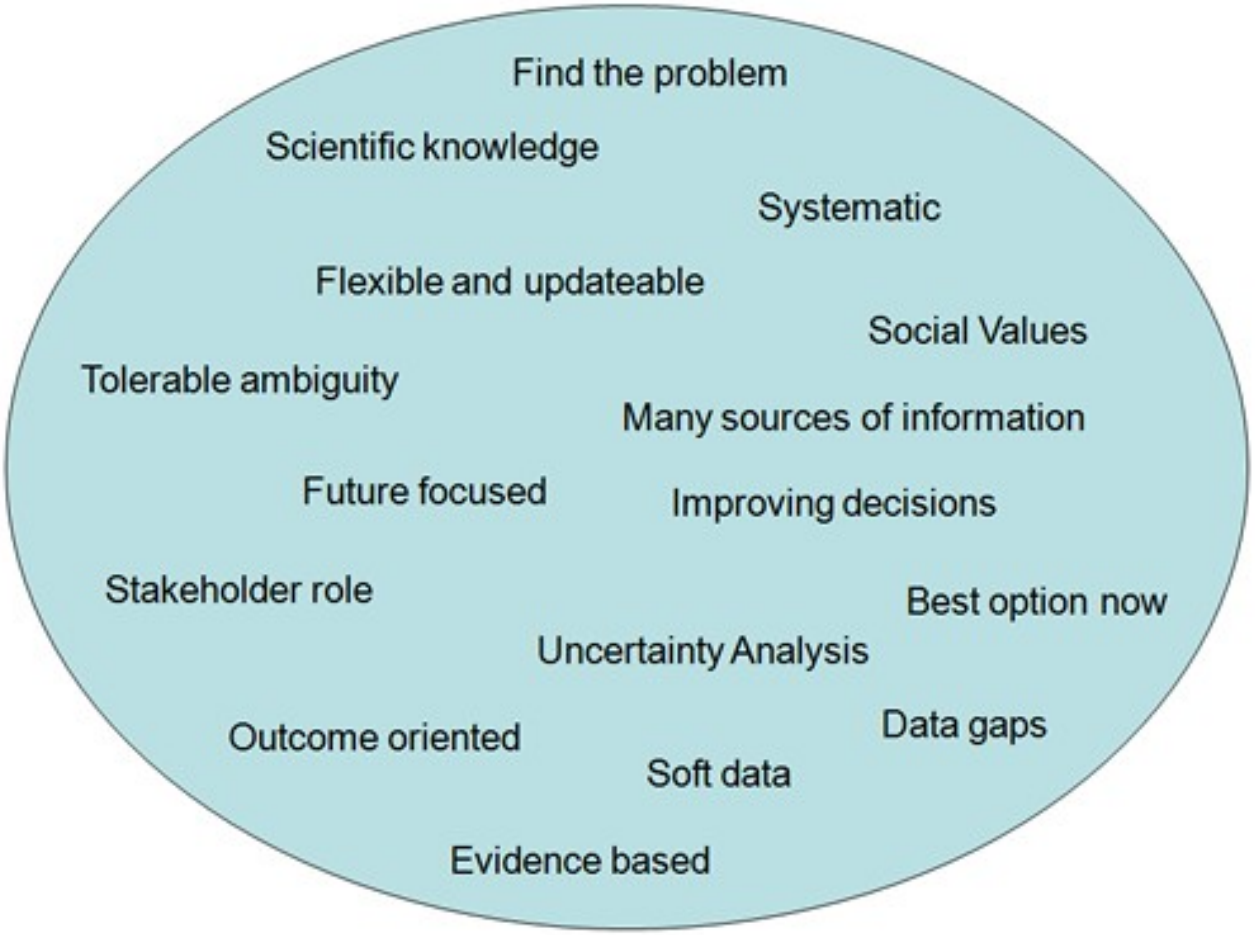
The simple answer is to counter "***uncertainty.***"

Risk analysis is a framework developed to aid decision-making under such conditions
of uncertainty.

What is Risk Analysis?

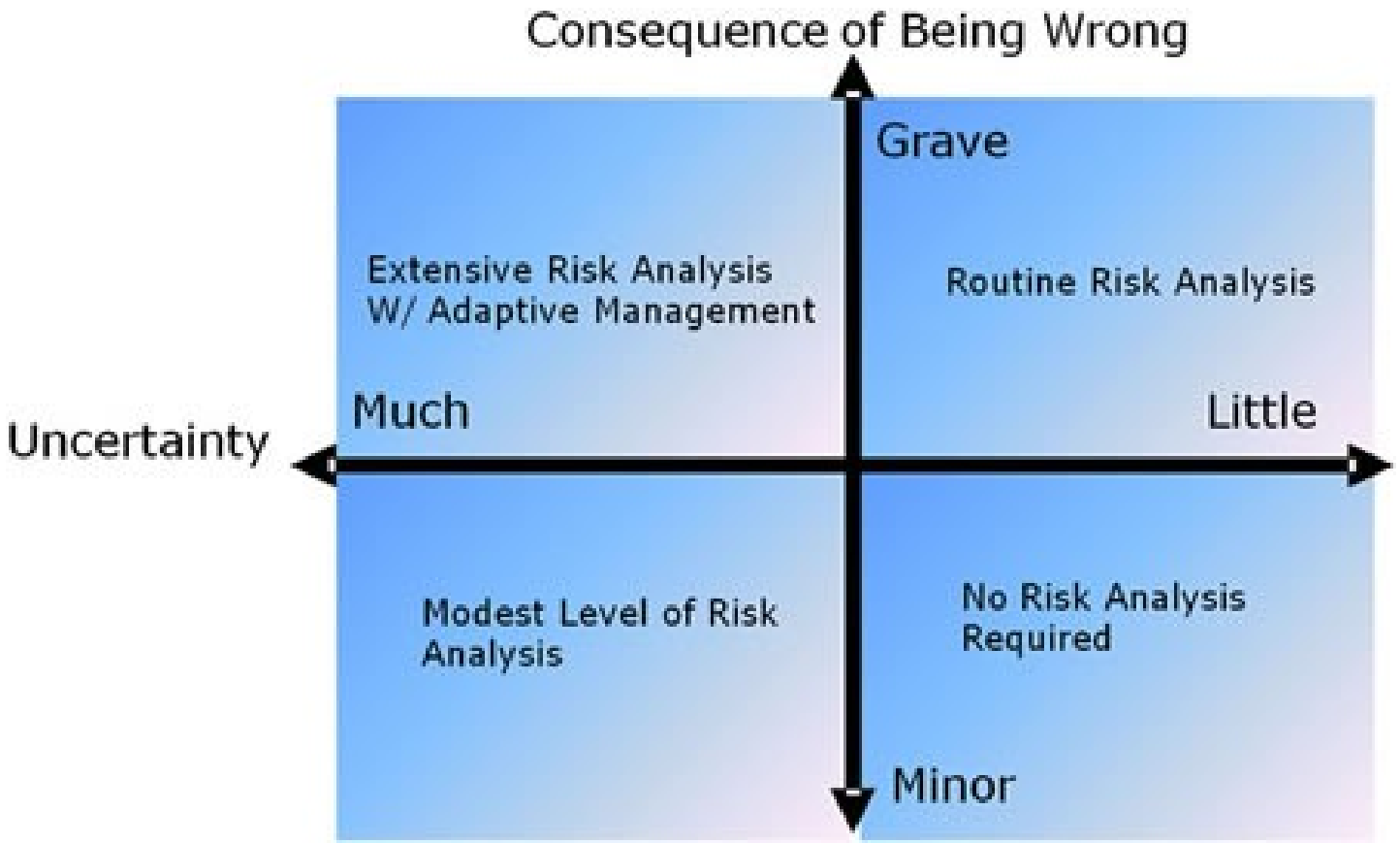


Risk Analysis



When to Do Risk Analysis

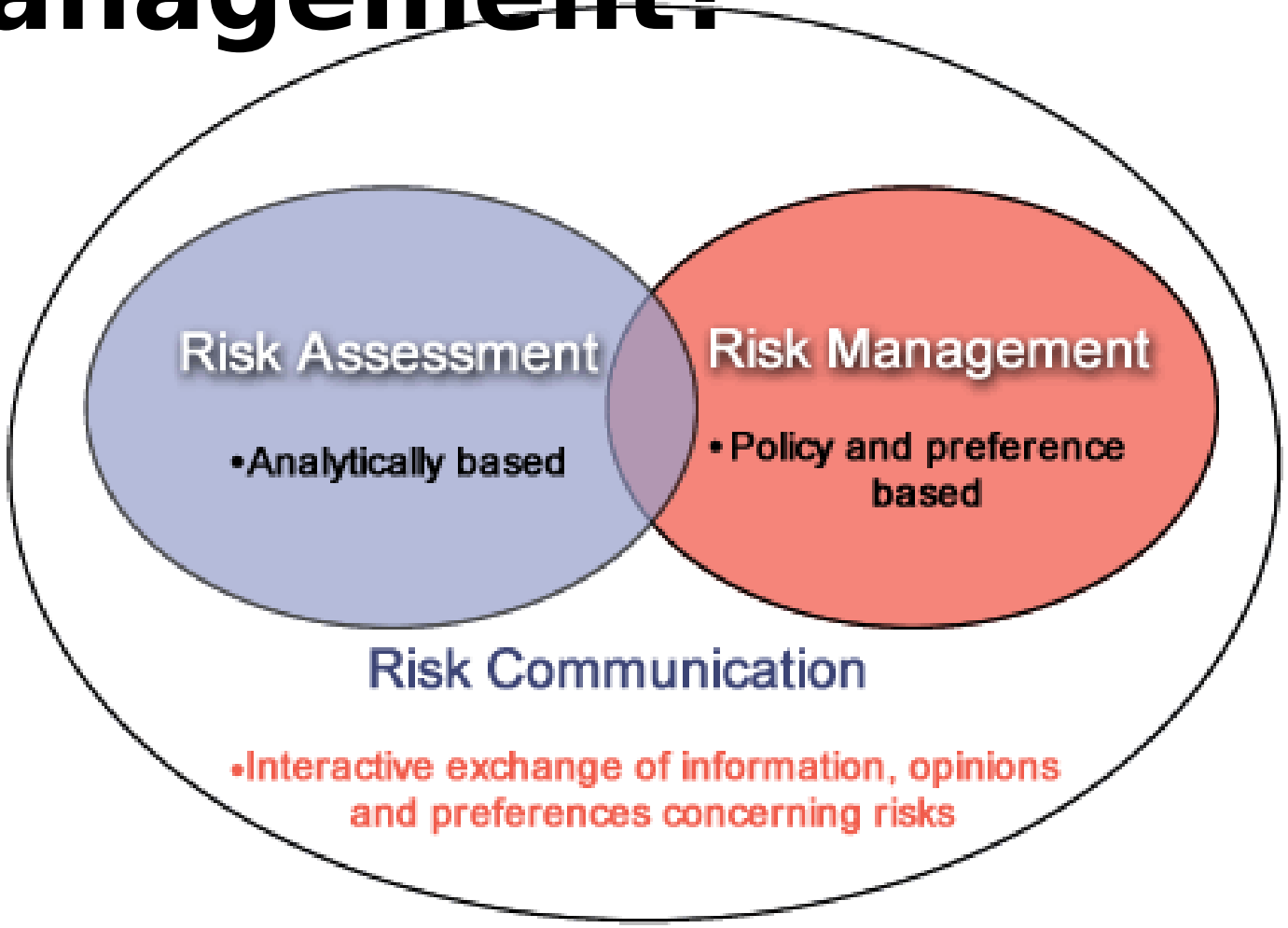
The two main things to consider when deciding if analysis is required are:



Corps Use of Risk Analysis

- Expected annual damages
- Major rehabilitation
- Establishment of design levels
- Risk-informed cost estimation
- Dam safety program
- Levee safety program
- Establishment of product safety standards, performance standards and specifications
- Risk-based software tool
- Scenario planning
- Scientific sampling protocols

What is Risk Management?

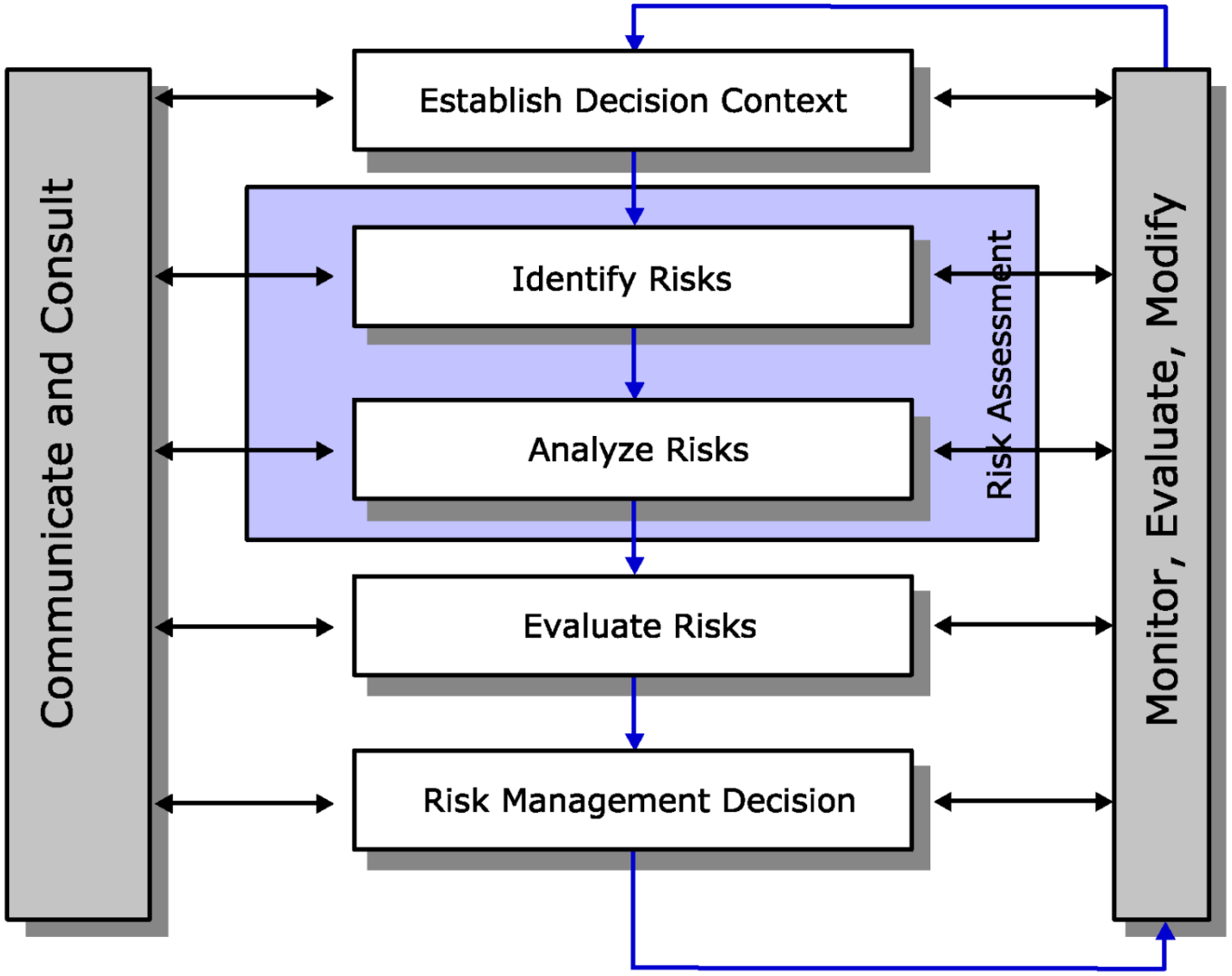


Defining Risk Management

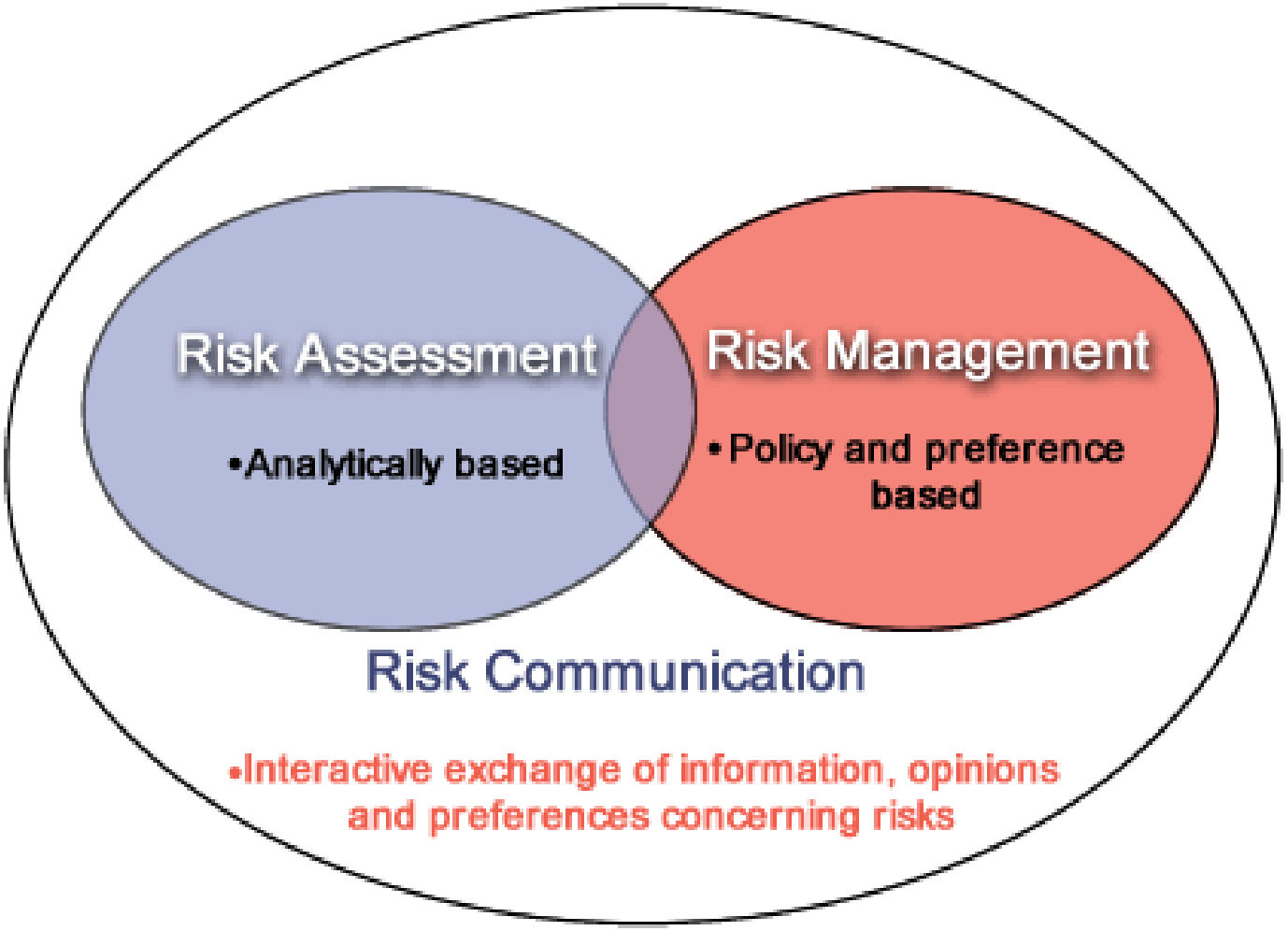
Answer these questions and you are doing risk managemen

- What is the problem?
- What question(s) do we want risk assessment to answer?
- What can be done to reduce the impact of the risk described?
- What can be done to reduce the likelihood of the risk described?
- What are the trade-offs of the available options?
- What is the best way to address the described risk?
- Is it working?

Corps Risk Management Model



What is Risk A



Risk Assessment Defined

"***Risk assessment is a systematic, evidence-based approach for quantifying and describing the nature, likelihood and magnitude of risk associated with the current condition and the same values resulting from a changed condition due to some action.“***

Ask and answer these questions and you are doing risk assessment.

What can go wrong? ID Hazards or Opportunities

What are the consequences? Assess Consequences

How likely is it? Assess Likelihood

Step 1:

ID Hazards/Opportunities

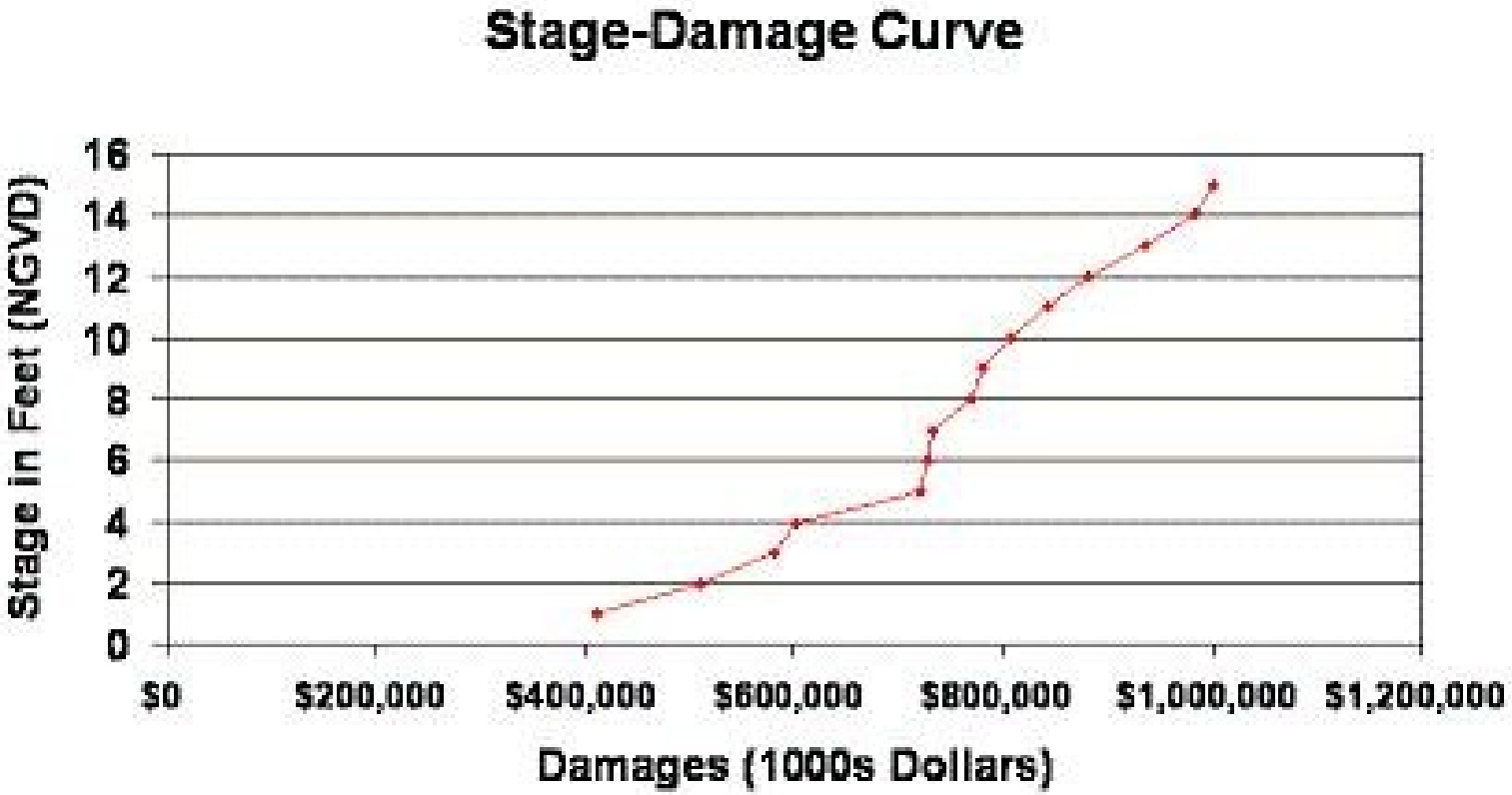
This step is focused on identifying the hazards that can cause harm or the opportunities for gain that are uncertain.

In evaluating these factors flood risk managers are addressing the first two questions of risk analysis: What can go wrong and how can it happen?

- **Flood flows**
- **Property damages**
- **Loss of life**
- **Infrastructure failures**
- **Cost overruns**
- **Unpredictable budgets**
- **Environmental impacts**
- **Ecosystem restoration benefits**
- **Economic (re)development**

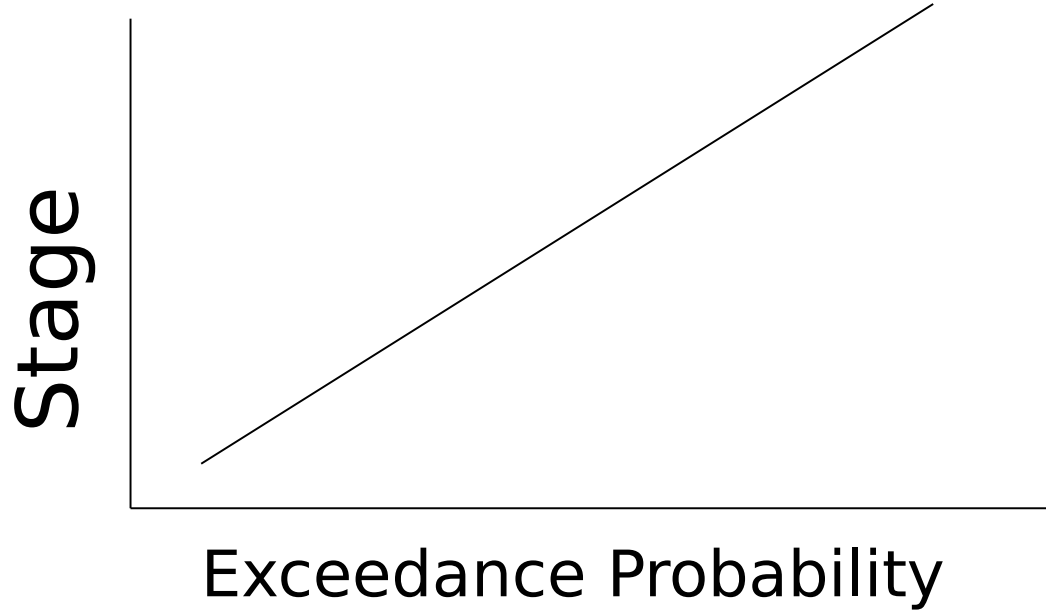
Step 2: Consequence Assessment

In this step we decide who or what may be harmed or benefited and in what ways. We gather and analyze the relevant data and characterize the consequences qualitatively or quantitatively



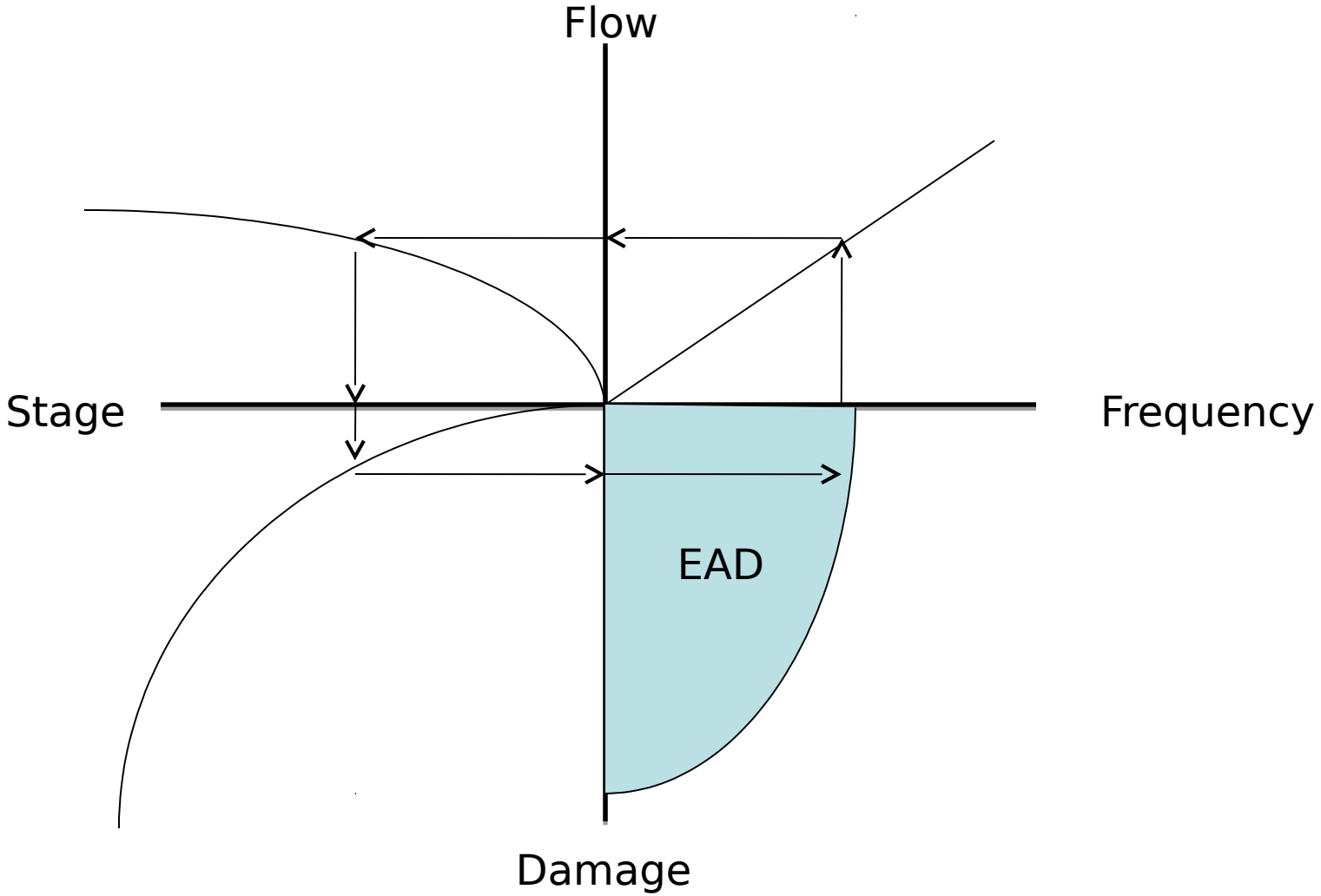
Step 3: Assess Likelihood

In this step we assess the likelihood of the various good and bad consequences and begin to characterize these likelihoods qualitatively or quantitatively.

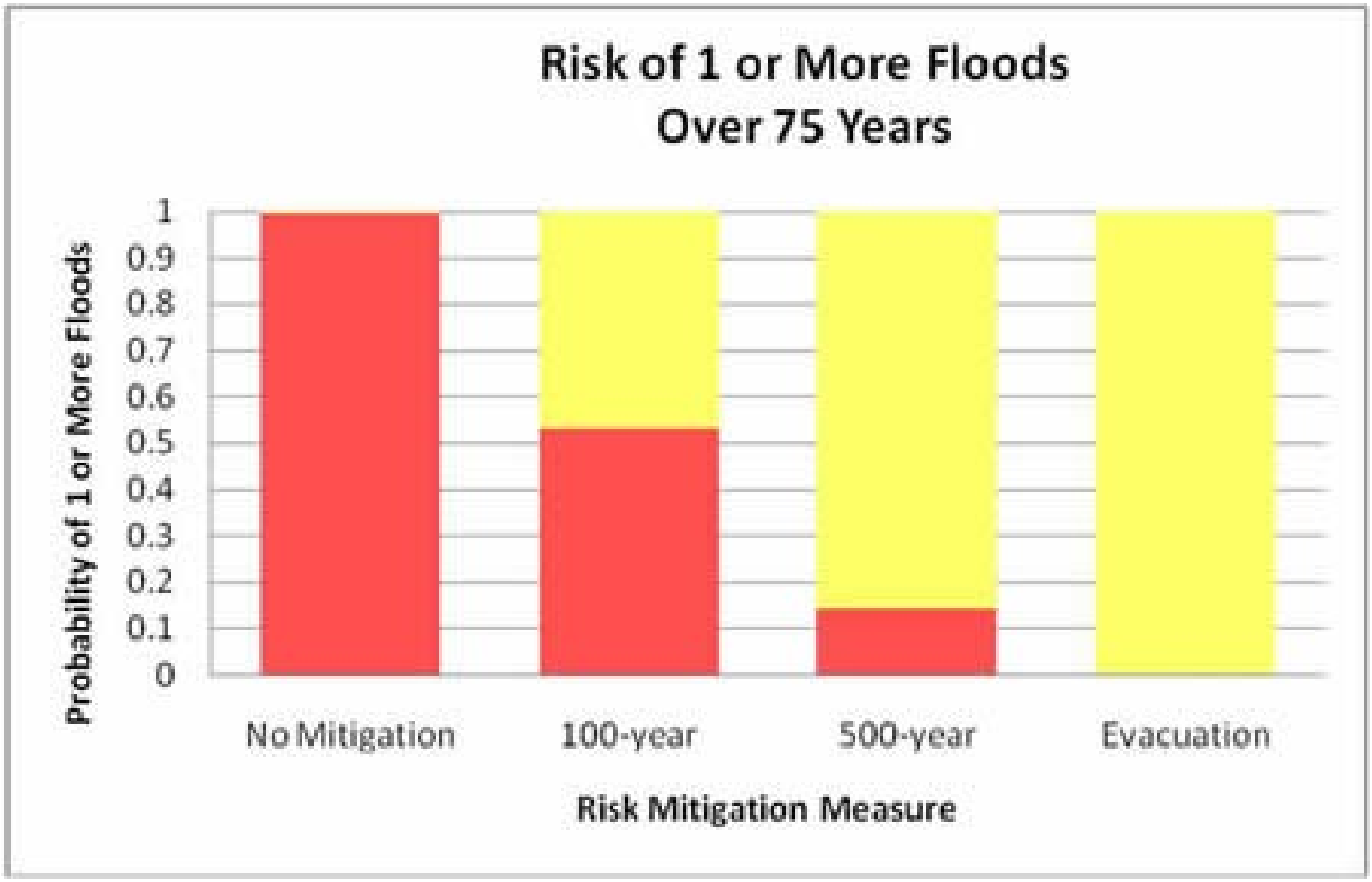


When Corps hydrologists develop a frequency curve, they are contributing to the likelihood assessment. This step continues to address "how can it happen" while adding a focus on the "how likely is it" question of our informal definition of risk assessment.

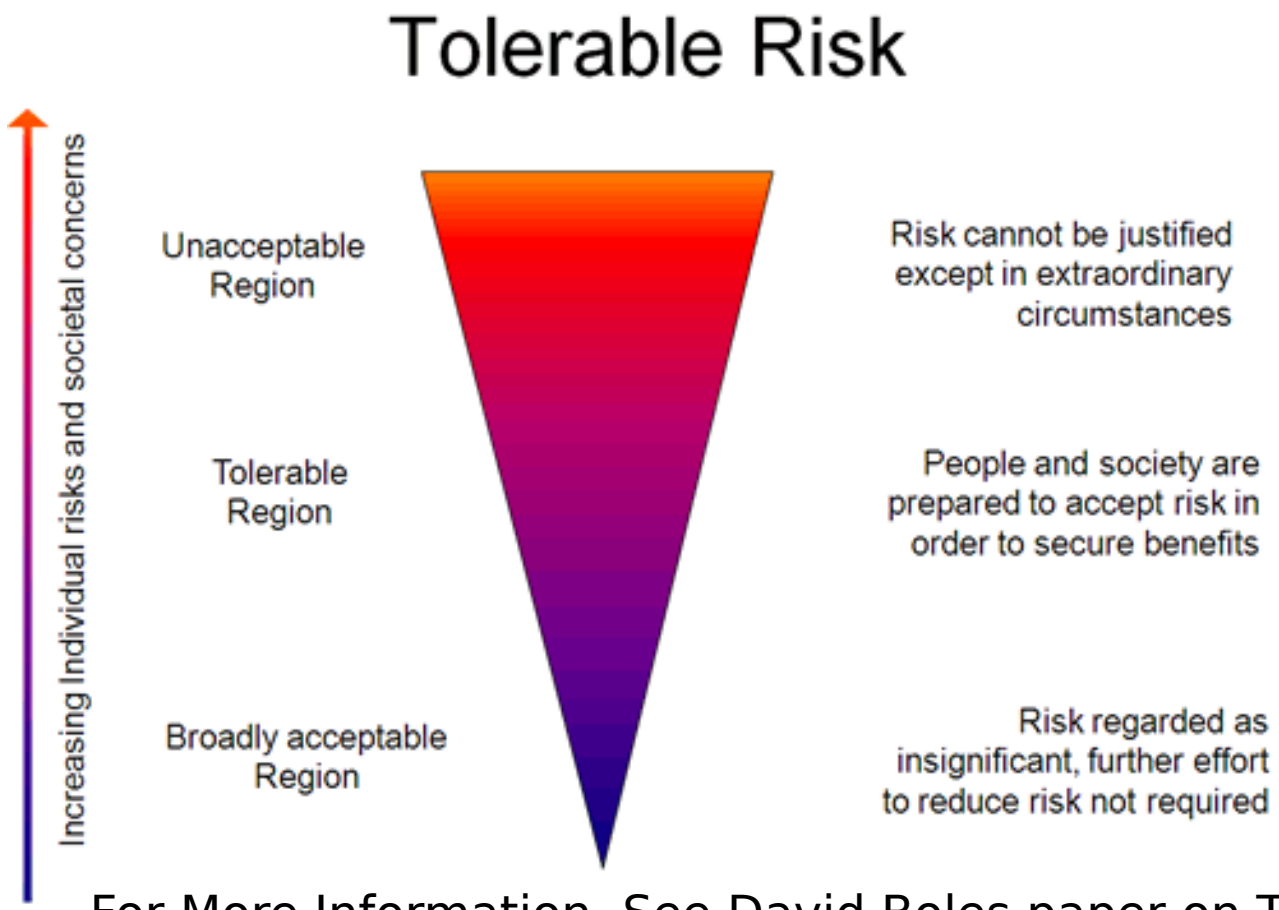
Step 4: Characterize Risk



What You May Not Know About Flood "Protection"



Tolerable Levels of Risk


Tolerable Risk
Increasing Individual risks and societal concerns
Unacceptable Region
Tolerable Region
Broadly acceptable Region
Risk cannot be justified except in extraordinary circumstances
People and society are prepared to accept risk in order to secure benefits
Risk regarded as insignificant, further effort to reduce risk not required

For More Information, See David Boles paper on Tolerable Risk for Dams http://uwrl.usu.edu/www/faculty/DSB/tolerablerisk.pdf

Or the IWR Report on Tolerable Risk for Levees http://www.iwr.usace.army.mil/docs/iwrreports/10-R-

TEST YOUR RISK INTUITION

Test your own risk intuition. Imagine that you live in a home located in the 10-year floodplain, i.e., a flow with an annual exceedence frequency of 0.1 or less will flood you.

- **What is the probability you will be flooded this year?** **10%**
- **If you live there for 10 years what is the probability you will be flooded one or more times? 1 or more times** **65.1%**
- **If you live there for 30 years (the duration of a common mortgage) what is the probability you will be flooded one or more times? 1 or more times** **95.8%**
- **If you live there for 75 years what is the probability you will be flooded one or more times?** **99.96%**

The Rest of the Risk Story

Estimating existing and future risks is an easy focus for most risk assessment. It can be equally important, though, at times to look at other aspects of risk including:

- Residual risk
- Transformed risk
- Transferred risk

Risk Assessor's Toolbox

Qualitative tools tend not to rely on numerical expressions of risk. Qualitative tools include:

- Narratives
- Ordering Techniques
- Enhanced Criteria Ranking
- Evaluation Framework
- Sensitivity Analysis
- Scenario Planning

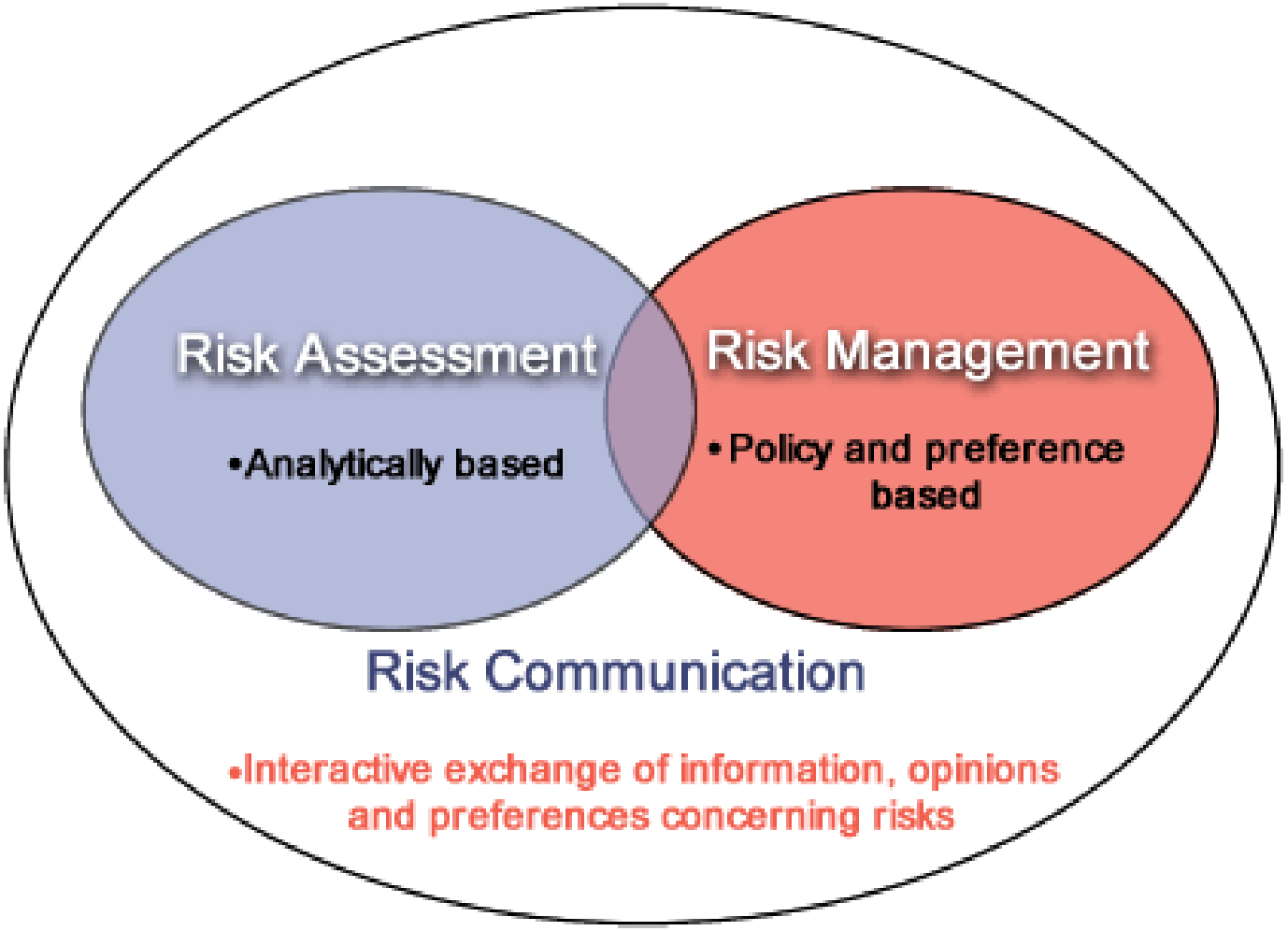
Quantitative tools rely on numerical expressions of risk. Quantitative tools include:

- Deterministic scenario analysis
- Probabilistic scenario analysis

There are also several tools that can be used with either qualitative or quantitative risk assessments.

Adaptive Management
Premise Sets
Multi-Criteria Decision Analysis
Corps Software Tools
Other Techniques

What is Risk C



Risk Communication

"Risk communication is the open, two-way exchange of information and opinion about hazards and risks leading to a better understanding of the risks and better risk management decisions. Risk communication is integrated into the assessment and management processes. It is not a task that occurs only after decisions have been made. Risk communication ensures that the decision makers, other stakeholders and affected parties understand and appreciate the process of risk assessment and in so doing can be fully

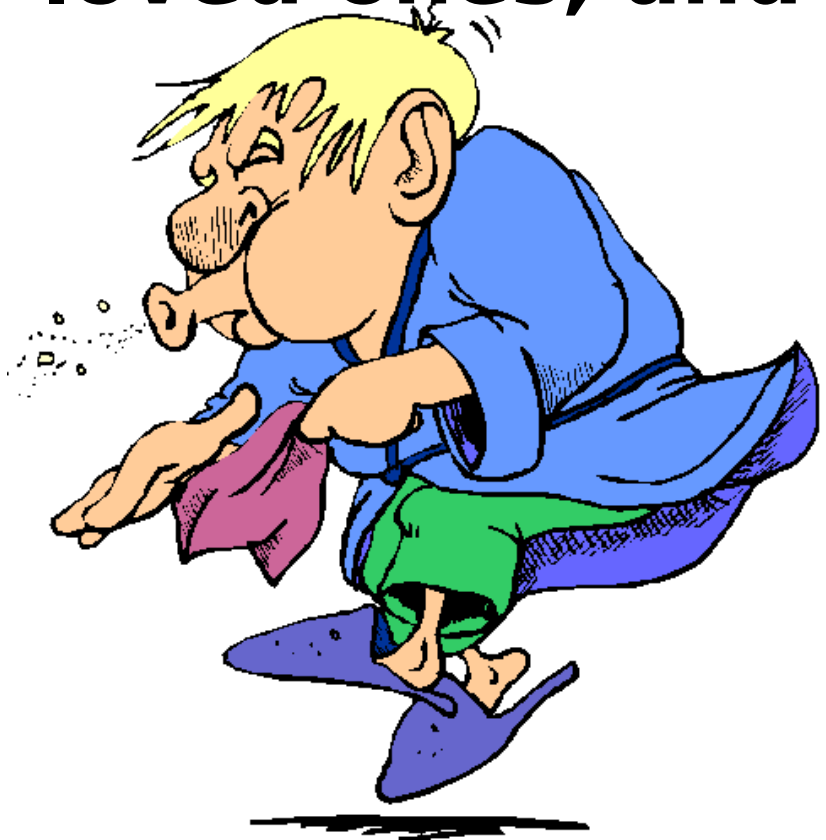
What Risk Communication Is and Is Not

- Tailor communication so it takes into account the emotional response to an event
- Empower stakeholders and public to make informed decisions
- Prevent negative behavior and/or encourage constructive responses to crisis or danger

Risk Communication Examples

“The best way to guard against the flu is to get vaccinated, which helps to protect you, your loved ones, and your community.”

CDC official
September 2006



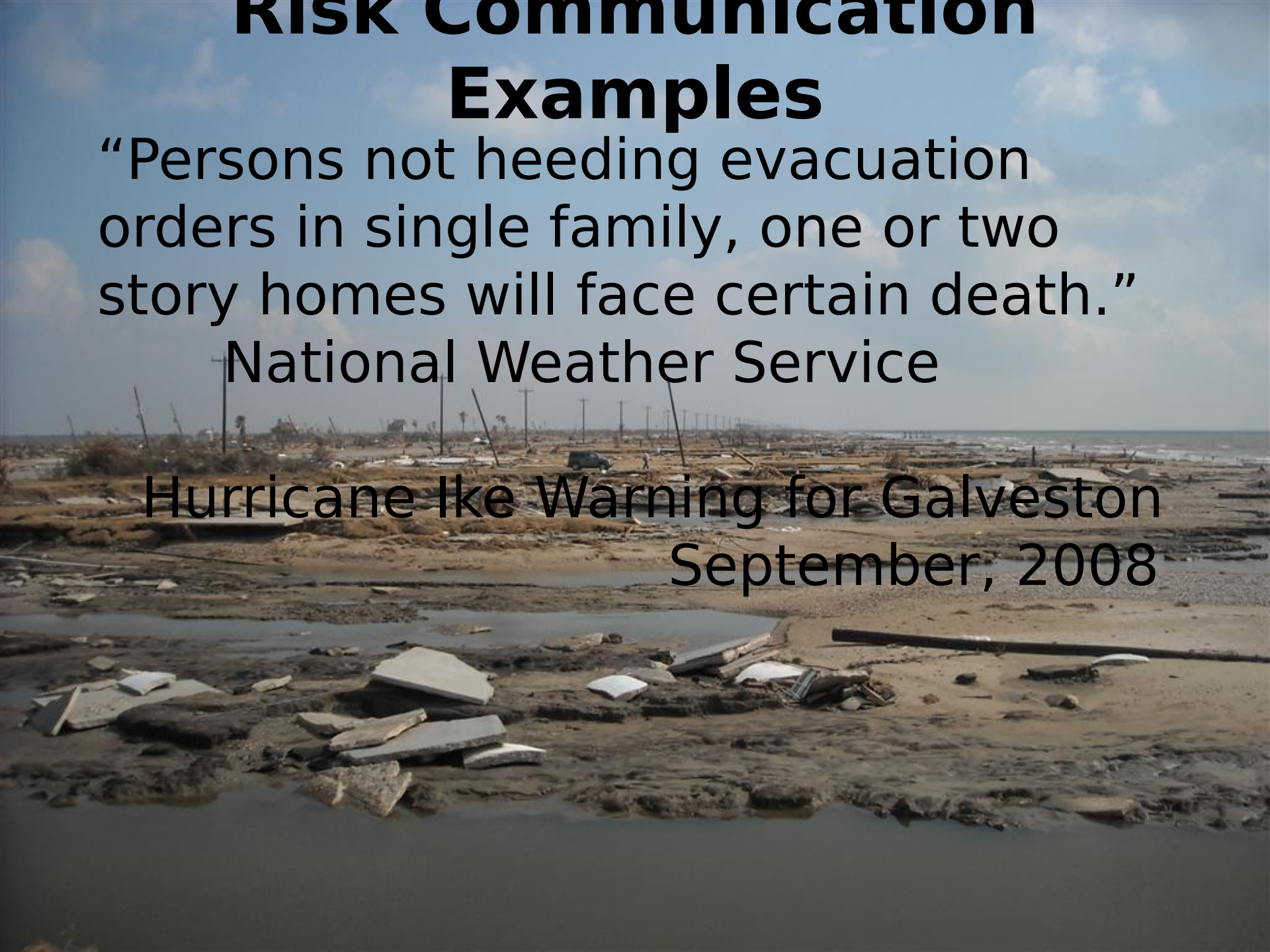
Risk Communication Examples

"Persons not heeding evacuation orders in single family, one or two story homes will face certain death."

National Weather Service

Hurricane Ike Warning for Galveston

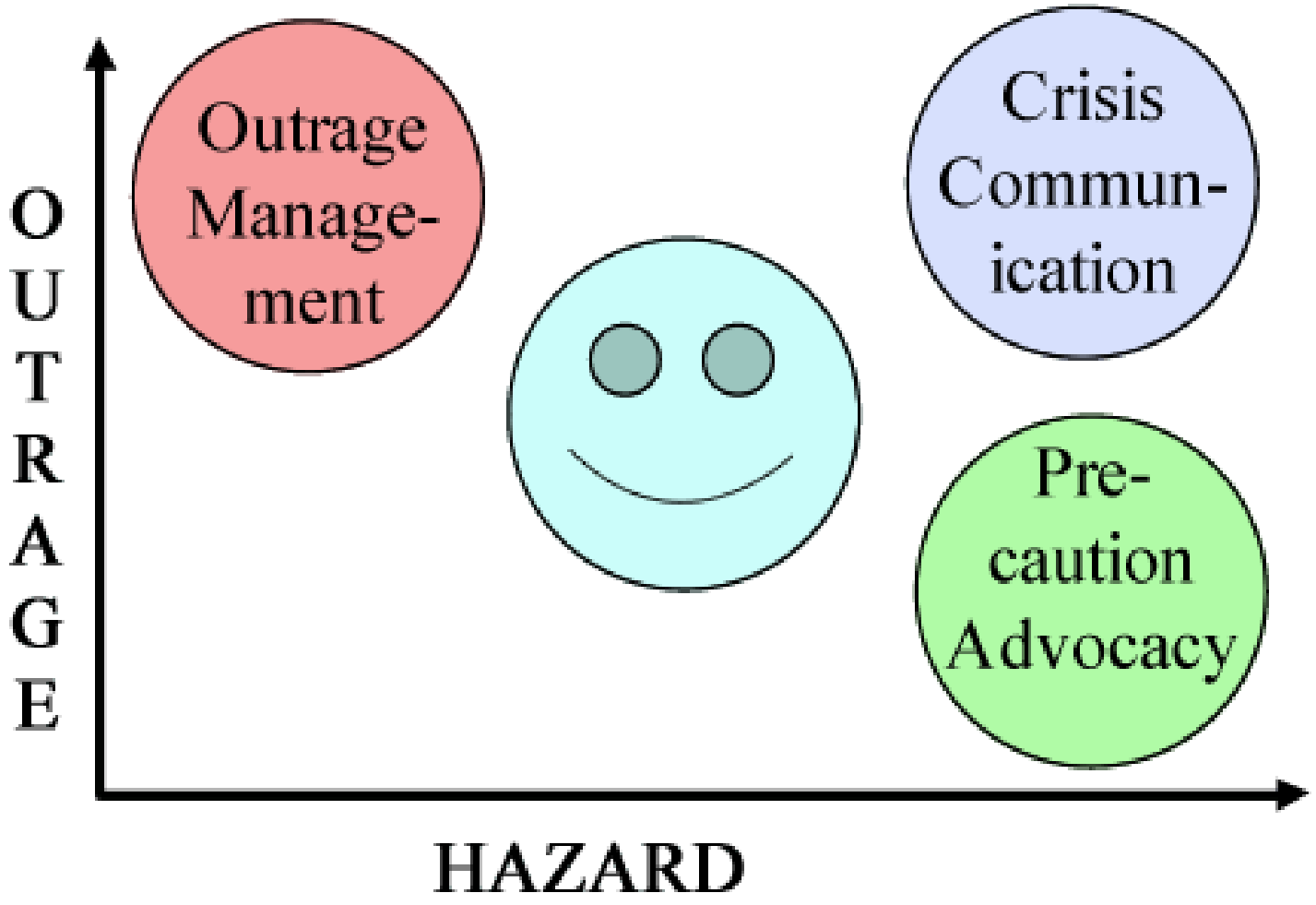
September, 2008



Elements of Risk Communication

Audience assessment — *know the public*
Audience involvement — *involve the public as partners*
Message — *information content*
Logistics — *how you get the content, how you get it to the audience, how you get their response back*
Listening — *for audience response*
Metamessaging — *the larger, holistic meaning of a message, the attitude communicated by the message sender, how you say it, reflects how communicator and audience feel about event*
Self-assessment — *on-going*
Evaluation — *lessons learned*

Risk Perceptions


Outrage Manage-ment
Crisis Commun-ication
Pre-caution Advocacy
OUTRAGE
HAZARD

Risk Communication Outcome

Risk Communication Resources

- Resources concerning risk communication include:
- **WEBSITES**
- Corps Risk Guidance, List of Resources
- Harvard Center for Risk Analysis
- Journal for Flood Risk Management
- Journal of Risk Research
- National Flood Risk Management Program
- Public Participation and Risk Communication
- Risk Analysis, An International Journal
- Risk World
- RISKANAL Discussion Group and Mailing List
- Society for Risk Analysis
- The Wharton School, Risk Management and Decision Processes Center
- Thesaurus of Terms Used in Microbial Risk Assessment, Environmental Protection Agency (EPA)
- **DOCUMENTS**
- The Application of Risk Communication to Food Standards and Safety Matters *(pdf, 303 KB)*
- Incorporation Risk and Uncertainty Into Environmental Evaluation: An Annotated Bibliography *(pdf, 661 KB)*
- Institute for Water Resources Publications
- IWR 96-R-14: Applied Risk Communication Within the Corps of Engineers *(pdf, 671 KB)*
- Managing Risk: Presentation to ASFPM 2008 Annual Conference
- OMB M-07-24L Updated Principles for Risk Analysis *(pdf, 163 KB)*
- OMB Scientific Review of the Proposed Risk Assessment Bulletin
- Public Perception of the Risks of Floods: Implications for Communication, Risk Analysis Journal *(pdf, 1.16 MB)*
- Risk as Analysis and Risk as Feeling: Some Thoughts about Affect, Reason, Risk, and Rationality, Risk Analysis Journal
- Risk Management Framework (A White Paper on the Corps Application)
- Risk Technology Workshop: Executive Overview (July 2010)
- Risk Technology Workshop: Expert Opinion Elicitation (July 2010)
- Risk Technology Workshop: Risk Communication (July 2010)
- Risk Technology Workshop: Why Risk Analysis? (July 2010)
- Transforming the Corps into a Risk Managing Organization *(pdf, 333 KB)*

“The planner’s primary role in dealing with risk and uncertainty is to ***identify the areas of sensitivity and describe them clearly so that decisions can be made with knowledge of the degree of reliability of available information***”

Corps Risk Guidance

- Economic And Environmental Principles And Guidelines For Water And Related Land Resources Implementation Studies
  http://www.usace.army.mil/CECW/PlanningCOP/Documents/library/Principles_Guidelines.pdf
- WRDA 2007, Sections 2021, 2022, and 2024
- Planning Guidance Notebook (ER 1105-2-100)
- http://140.194.76.129/publications/eng-regs/er1105-2-100/toc.htm
- Risk Analysis for Flood Damage Reduction Studies (ER-1105-2-101)
- http://140.194.76.129/publications/eng-regs/er1105-2-101/entire.pdf
- Updated Principles for Risk Analysis (Executive Office Memo M-07-24)
- http://www.whitehouse.gov/omb/memoranda/fy2007/m07-24.pdf
- Principles for Risk Analysis (Office of Management and Budget Memo, 1995)
- http://www.whitehouse.gov/omb/inforeg/regpol/jan1995_risk_analysis_principles.pdf